Interactive comment on "Modeling nitrate from land-surface to wells' perforations under agricultural land: success, failure, and future scenarios in a Mediterranean case study" *by* Yehuda Levy et al.

Anonymous Referee #1

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I enjoyed reading this manuscript. The topic of nitrate variability in groundwater is important for environmental concerns and raises scientific questions about causes of spatial gradients. The meaning of the text is generally clear. The data and model results are interesting. I recommend moderate revisions to clarify some details of the models and to further emphasize the scientific implications of the work.

Title – consider revising to emphasize the main scientific issue (spatial variability of nitrate?). One option is to replace "success, failure" (which can be misunderstood) with "spatial variability." Abstract - Consider stating the scientific problem early in the

abstract (e.g. Can spatial variability of nitrate, be characterized on the basis of land use and standard agricultural practices?)

61 – Consider also mentioning that nitrate is discharged to streams or other surface water receptors, which can be a major concern.

64 – should this say "significant spatial variability"?

75-80 – In the statement of objectives, consider making the scientific implications (e.g. explaining the spatial variability of nitrate) more prominent, and perhaps de-emphasize the model-specific and site-specific elements.

77 – should "restore" be "estimate"?

100 – consider defining aerial coefficient of variation mathematically

145-150 – Are agricultural-chemical source of Cl important (e.g. KCl)? Are these accounted for in the mass balance?

227 – consider spelling out "Israel Water Authority" here.

245 – consider changing "strictly kept" to "kept constant" or something similar

248 - Section 2.3.3. – This is quite brief and readers will have additional questions, e.g. about initial conditions and boundary conditions for NO_3^- concentrations.

297 – Table 3 – Spell out "Crop Mass Balance" or define CMB in caption or table footnote.

306 – spell out MAE (mean absolute error?)

307 – It is not clear what is meant by "the improvement in the calibration ceased when...". Is the meaning that calibration efforts were stopped when MAE <0.5 and bias <0.1? And/or that it was difficult to improve results beyond those cutoff values?

314 – Should this say "initial transport parameters"? (is this 500m value the one referred to in the previous sentence?)

316 – consider revising to "mean nitrate concentration for the entire modeled area"

318-319 – "The model reconstructed…" This seems repetitive and can be omitted.

326 and onward – It seems that the need for "multipliers" is a key result of the paper, because it indicates that nitrate variability is greater than can be explained by variation of crop-specific agricultural practices and physical processes, to the extent that they are simulated here. I suggest revising to emphasize this scientific significance, and to put less emphasis on the technical role of multipliers as an ad-hoc solution to a modeling problem. In other words, consider revising the language so that readers can see that the two models (with and without multipliers) address the scientific question of whether nitrate variability can be explained by general crop-type practices and the other factors considered in the numerical models.

Also, it would be helpful to further emphasize in the discussion how this result fits into the existing literature. For example, homogeneous NO_3- input functions have been used with some success in local-scale (e.g.. single field) studies to explain spatially varying NO_3- concentrations (e.g. Liao et al., 2012 http://onlinelibrary.wiley.com/doi/10.1029/2011WR011008/full ; Alikhani et al., 2016 http://www.sciencedirect.com/science/article/pii/S0022169416302098). In regional scale studies, it has been established that a homogeneous input function typically does not suffice, and multipliers similar to those of this study have been implemented (e.g. Green et al., 2016 http://www.sciencedirect.com/science/article/pii/S0022169416302852). This current study can be seen as a logical extension of the previous studies because it tests the extent to which the input function of NO_3- can be improved, or even directly estimated from general agricultural practices and vadose zone characteristics. So in combining the current and previous studies, perhaps the authors could comment further on typical scales of variability (e.g. if intra-field variability of fertilizer applications were an issue, would the previous field-scale studies with homogeneous N-inputs have succeeded as well as they did?), the factors that may account for the variability

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(some already included in discussion), and/or related topics to inspire future research directions.

335 – consider adding a sentence to note that the physical significance of the multipliers will be addressed in the discussion section.

349 – change "on average for" to "as an average of". Consider clarifying/acknowledging that even though the average is less than 70 mg/L, there would still be some wells exceeding that limit.

362 – consider changing "coarse" to "approximate" or "first-order" or something similar

368 – I suggest not using the word "failure", as it can be misinterpreted as referring to the model itself, rather than to the relative smoothness of NO_3- spatial gradients in the model as compared to measurements – a result which successfully addresses the scientific objectives of the study.

370 – The specific explanation here (intra-field variability) seems to be given without consideration of additional possibilities that are discussed later in this section (E.g. rapid transport in bore hole annulus)

376-378 – I don't follow the logic of this text.

378 – I suggest changing "non-physical" to "heuristic".